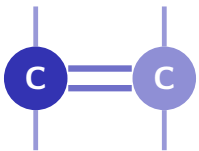
Hydrocarbons

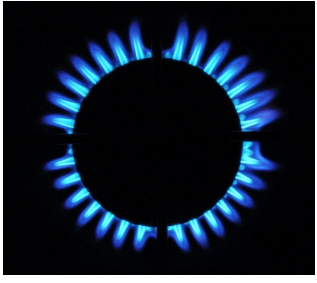
A-Level Chemistry ▪ Topic 14

A-Level Chemistry



What we will cover

1. Alkanes: making & combustion
2. Free-radical substitution
3. Alkenes & their reactions
4. The bromine test
5. Addition polymerisation
6. Markovnikov's rule



methane, the simplest alkane

Alkanes: making and combustion

complete 完全燃烧

plenty of $O_2 \rightarrow CO_2 + H_2O$

incomplete 不完全燃烧

too little $O_2 \rightarrow CO$ + soot

Alkanes 烷烃 (C_nH_{2n+2}) are made by **hydrogenation** 氢化 of alkenes or **cracking** 裂化; they are unreactive (strong, non-polar bonds).

Free-radical substitution

1. **initiation** $Cl_2 \xrightarrow{UV} 2\,Cl^{\bullet}$
   UV light splits Cl–Cl into two radicals
2. **propagation** $Cl^{\bullet} + C_2H_6 \longrightarrow C_2H_5^{\bullet} + HCl$
   $C_2H_5^{\bullet} + Cl_2 \longrightarrow C_2H_5Cl + Cl^{\bullet}$
   each radical makes a new radical, so the chain continues
3. **termination** $Cl^{\bullet} + C_2H_5^{\bullet} \longrightarrow C_2H_5Cl$
   two radicals join, ending the chain

Alkanes react with a halogen in **UV light** 紫外线:

- **initiation** 引发 – UV makes radicals
- **propagation** 增长 – carries the chain
- **termination** 终止 – two radicals join

Alkenes and their reactions

Alkenes 烯烃 (C_nH_{2n}) have a reactive C=C, attacked by **electrophilic addition** 亲电加成:

- H_2/Ni $\rightarrow$ alkane; steam $\rightarrow$ alcohol
- HX $\rightarrow$ halogenoalkane; X_2 $\rightarrow$ dihalide

The bromine test

shake with orange bromine water

with an **alkene**

turns colourless (decolourised)

with an **alkane**

stays orange (no reaction)

Shake with orange **bromine water** 溴水:

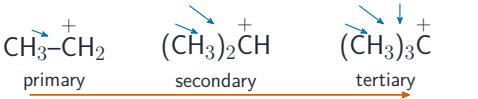
> An alkene decolourises it (electrophilic addition); an alkane leaves it orange.

Addition polymerisation

ethene (monomer) poly(ethene)

In **addition polymerisation** 加成聚合, many alkene molecules open their C=C and join into one long chain – with no other product. Ethene → poly(ethene), a **polymer** 聚合物.

Mechanism and Markovnikov's rule



Markovnikov: HBr adds so the *more stable* carbocation forms

A **carbocation** 碳正离子 forms in electrophilic addition.

Alkyl groups push electrons in (the **inductive effect** 诱导效应), so tertiary > secondary > primary – the more stable one forms (**Markovnikov's rule** 马氏规则).

Worked example – which product is major?

But-1-ene reacts with HBr. Name the major product and explain why.

- The C=C π electrons attack the $\delta+$ H of H–Br: electrophilic addition.
- Two **carbocations** 碳正离子 are possible: a secondary one or a primary one.
- Alkyl groups push electron density in, spreading the charge, so the secondary is more stable.
- Br^- attacks it: major product 2-bromobutane.

Always route through the more stable carbocation. Stability: tertiary $>$ secondary $>$ primary.

Topic 14 – key takeaways

1 Alkanes

combustion; free-radical substitution in UV

2 Alkenes

electrophilic addition across C=C

3 Bromine test

alkene decolourises bromine water

4 Markovnikov

the more stable carbocation forms

Check yourself

1. What two products does incomplete combustion add?
2. What light is needed for free-radical substitution?
3. What does an alkene do to bromine water?
4. Which carbocation is most stable: 1°, 2° or 3°?

Answers **1.** carbon monoxide and soot **2.** ultraviolet **3.** decolourises it **4.** tertiary (3°)